Faculty of Resource Science and Technology

GROWTH RESPONSE OF *LICUALA SPINOSA* THUNBERG UNDER FERTILISER APPLICATION

Elman Bin Pendi

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ELMAN B. PENDI

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Growth Response of *Licuala spinosa* Thunberg under fertiliser application

Elman Pendi

Plant Resource Science and Management Programme
Faculty of Resource Science and Technology
University Malaysia Sarawak

ABSTRACT

Licuala spinosa Thunberg is a valuable ornamental tree species in the Palmae family. The growth response of *L. spinosa* seedlings under 25 g, 50 g, 75 g, and 100 g of fertilisation for 5 months was investigated to determine the optimum fertiliser for plant growth. Application of 25 g of fertiliser resulted in better growth in terms of height, diameter, and leaves growth of *L. spinosa* seedlings. Application of greater than 25 g of fertiliser did not increase the growth performance. The importance role of fertiliser in plant growth for landscaping is discussed.

Key words: *L. spinosa*, fertilisation, plant growth, landscape

ABSTRAK

Licuala spinosa Thunberg merupakan spesies pokok hiasan yang sangat bernilai dalam family Palmae. Pemerhatian terhadap kajian tindak balas pertumbuhan anak pokok L. spinosa di bawah aplikasi pembajaan sebanyak 25 g, 50 g, 75 g, dan 100 g selama 5 bulan telah dilakukan untuk menentukan tahap pembajaan optimum untuk pertumbuhannya. Aplikasi baja sebanyak 25 g telah menunjukkan pertumbuhan yang terbaik dari aspek ketinggian, diameter, dan bilangan daun anak pokok L. spinosa. Manakala aplikasi baja melebihi 25 g pula tidak menunjukkan pertumbuhan yang baik. Kepentingan aspek pembajaan dalam pertumbuhan pokok ini untuk landskap diperbincangkan.

Kata kunci: L. spinosa, tahap pembajaan, pertumbuhan pokok, landskap

CHAPTER 1

INTRODUCTION

1.1 Importance of Urban Forest or Urban Greening

Urban forests play a pivotal role in the environmental, aesthetic, architectural, and engineering functions of landscape (Clark and Matheny, 1994; David, 1996; Grey and Deneke, 1986; Duryea *et al.*, 1996; Souch and Souch, 1993). They are able to modify urban microclimates, which in turn affect human comfort and interior energy budgets (Barro et al., 1996; Laverne and Lewis, 1996; Miller, 1997; McPherson and Luttinac, 1998; Simpson and McPherson, 1996; Summit and McPherson, 1998).

The presence of urban trees and forests can make the urban environment a more pleasant place to live, work, and spend leisure time. Studies of urbanite preferences and behavior confirm the strong contribution that trees and forest make to the quality of life in urban areas. However, the effectiveness of urban trees and forests in providing benefits to people depends on their species composition, diversity, age and location with respect to people and other elements in the landscape (Dwyer et al., 1992).

Urban forests can also enhance the quality of live by providing restorative environments for reducing the mental fatigue of the urban residents (Ulrich, 1984). For example, Ulrich found those hospital patients with window views of tree recover significantly faster and with fewer complications than comparable patients without access to such views. The presence of urban trees and forest can reduce stress and improved physical health for urban residents. With this effect, the urban forests make a great contribution to the physical and psychological condition of the urban's inhabitants (Landsberg, 1981; Akbari et al., 1992; Sailor, 1995; Simpson and McPherson, 1996; Simpson, 1998). Urban forest intercepts solar energy directly by providing shade in areas where it is desired and by cooling the atmosphere through transpiration of water from the leave.

1.2 The Sarawak Scenario

Shade tree planting and maintenance is relatively change in Malaysia, compare to other cities in Europe and United States of America. In Kuching, many areas such as roadsides, highways and junctions (especially in Petra Jaya and Padawan) have been planted with trees of different species. The municipals Dewan Bandaraya Kuching Utara (DBKU) and Majlis Bandaraya Kuching Selatan (MBKS) are responsible to provide greenery to make urban areas more pleasant, fresh and comfortable. In line with the recognition of Kuching as a garden city, issues on landscaping is very important to look at as one of the factors that could promote the city as liveable and environmentally healthy.

Landscaping is involves improving the appearance and functions of a piece of land by reshaping and preparing the grounds, planting suitable plants, mulching of garden beds, installation of an adequate irrigation system and provision of ongoing maintenance. Landscape is not just supplementary aspect in development; instead it is a crucial contributor to the tourism sector and economic development in the country. Therefore, landscaping should be a must in any development project (Extracted from the former Prime Minister's speech during the official ceremony of Majlis Pelancaran Kempen Menanam Pokok Seluruh Negara, 3rd March 1997, Kuala Lumpur).

There are other cities in the State of Sarawak, which are in the process of planning and implementing proper landscaping for its towns and surrounding areas. For example, Miri, Bintulu and Sibu need proper planning for landscaping besides industrial, commercial and residential developments.

This will help the planners to design and create a better living environment that balances the needs of urbanisation with the need for a fresh and clean environment.

There are a number of issues and challenges in planning for a better landscaping for cities in the State of Sarawak. Among the issues are maintenance cost, expertise, planning frames, species selection and responsibilities. These issues should be thought thoroughly by the planner and decision-makers as well as other stakeholders in order to achieve a better city to work and live in the future. In the past, the species chooses for the landscapes in this country are based on their popularity especially tropical trees. The trees selected however must have certain criteria's such as to provide shade, have strong roots and trunks, branches, good aesthetic (artistic), and should not have hard fruits that could endanger passers by.

1.3 Significance of the study

The earlier review demonstrates that plant growth in urban areas is complex and plants are being exposed to various environmental stresses that contribute greatly to this complexity. Currently *Licuala spinosa* is among the most common tree species planted along roadside and highways in urban areas such as Kuching. It is therefore of interest to study in detail how this species perform and able to adapt to the harsh environment. Increasing our basic understanding of the relationship of urban site factors to tree stress like nutrient stress and health has a number of practical implications. These include providing guidelines for selecting better-adapted trees for urban sites and developing management strategies that can reduce tree stress.

CHAPTER 2
LITERATURE REVIEW

2.1 Urban Environment

The urban landscape can be hostile to tree growth in many ways. For example, a variety of biologically and physically important stresses limits tree growth in cities (Berrang *et al.*, 1985). These include soil compaction, lack of water, pollution, high temperature, and vandalism (Graves *et al.*, 1989, Hough, 1988; Krizek and Dubik, 1987; Whitelow et al., 1988). Hence due to these numerous constraints on tree growth, urban trees often have shorter lifespan in comparison with trees growing in natural stands (Berrang et al., 1985).

Urban soils have characteristics that are distinct from their natural counterparts. These characteristics include: great vertical and spatial variability; modified soil structure leading to compaction; presence of a surface crust on bare soil; restricted aeration and water drainage; interrupted nutrient cycling and modified soil organism activity; presence of anthropeic materials and modified soil temperature regimes (Craul, 1994). Urban soils also tend to have soil reaction (pH) values higher than their natural counterparts (Craul, 1992).

2.2 Nutrients and Urban Soil

The rates of growth and the size composition of plants depend on the environmental supply of nutrients. Plants obtain mineral nutrients mainly from the soil, but the amounts and proportions of different nutrients in the environment vary greatly and depend on the type of soil (Marschner, 1986). The urban soil generally lacks the organic matter cycling and the interaction of these characteristics presents problems to plants growing in urban areas (Craul, 1992).

Root growth is opportunistic, and occurs whenever environment is favorable: that is whenever sufficient oxygen, water, nutrients, and warmth can be found. The major factor controlling the survival and growth of an urban tree is its ability to produce a root system that successfully exploits a sufficient volume of soil to supply the moisture and mineral nutrients demands of the aerial organs.

The mineral nutrients exploited by plants are largely in ionic form, such as nitrate and plants may exploit forms depending on the conditions, example nitrate is sources of nitrogen for plants and largely metabolized to amino acids and used in protein synthesis (Bray, 1983). The amount of a nutrient available to plants depends on the concentrations of usable forms of nutrient in the environment and the efficiency of the plant in extracting the nutrients. If the nutrients supply falls below demand, photosynthesis decrease and growth slows. At very large supply or concentration of the nutrients to the plants, the plants biochemical and physiological mechanism may be damaged; example by large concentrations of ions which cannot be excluded by roots (Marshner, 1986).

The growth rate of trees in the landscape was highly correlated with their nitrogen concentration when they left the nursery. The higher the nitrogen content of the plant, the faster it grew but increased fertiliser rates in the nursery also decreased the stress tolerance once they were in the landscape.

2.3 Nitrogen

The previous study of fertiliser application, *Hopea odorata* seedlings receiving 30 g of fertiliser under well-watered conditions recorded the highest height and diameter increment. Meanwhile, *Mimusops elengi* seedlings receiving 50 g of fertiliser under well-watered condition recorded the highest height increment but the *M. elengi* seedlings treated with 30 g of fertiliser and well-watered recorded the highest diameter increment (Zainudin, 2003).

High nitrogen supply has been shown to reduce root-shoot ratios markedly in seedlings of other species (Ingestad, 1982). Nitrogen in soils occurs in several forms including as organic compounds, ammonium ion, nitrite, nitrate, nitrous oxide, and nitrogen gas. The largest concentration of nitrogen in surface soils is in the organic form.

Typically, the soil organic matter contains about 5% nitrogen. Additionally, a large part of the nitrogen in the lithosphere is in a fixed form within the earth's crust in rocks and sediments which is generally unavailable for plant uptake. The main form that nitrogen is taken up by plants is as either ammonium or nitrate. Nitrogen which is available to plants may come from decomposition of organic matter, biological fixation of nitrogen, and from additions of nitrogen in organic or inorganic fertilisers.

Low pH has been found to reduce nitrogen fixation. The most important free living species N_2 fixing bacteria belong to the genera Azobacter, Beijerinckia, Spirallum, and Enterobacter. Rhizobia species is the most common nitrogen fixers know to home gardeners. High levels of nitrogen in the forms of nitrates, nitrites, ammonium, and urea have been shown to decrease nitrogen fixation.

The resulting ammonium ion may be adsorbed by the clay and organic matter fraction of the soil, taken up the microorganism, be converted to nitrate, or fixed by clay mineral such as vermiculites and become unavailable for plant uptake (Pedrosa, *et al.*, 2005).

The nitrogen immobilized by microorganism may later become available for plant uptake. The release of nitrogen from microorganism is depending upon the carbon to nitrogen ratio of the soil. A ratio above 15 to 1 will result in nitrogen becoming unavailable to plants while below 15 to 1 will result in more nitrogen becoming available to plants. The ammonium ion if the pH of the soil is above 7.2 will be converted to ammonium gas which can be lost to the atmosphere.

An ammonium volatilization loss of ammonium based fertilizers is a common problem on alkaline soils. Urea when applied in the solid form may also be lost as ammonia gas on most regardless of the soil pH. When urea hydrolyzes it produce a pH of 9 or above around the area it is located so even in acid soil ammonia losses can be great.

Other factors which influence the amount of ammonia volatilization losses include temperature, moisture, wind, and ammonium ion concentrations. The higher the temperature is the great will be the losses of ammonia to the atmosphere. Wind can help increase losses of this gas because it removes the ammonia gas from the soil surface allowing more ammonia to diffuse out of the soil. Rainfall on the hand can reduce losses because it can leach the urea and ammonium ions deeper into the soil where they are more likely to be adsorbed by the soil. The higher the ammonium ion concentration if other conditions are right will result in higher ammonia gas losses (Pedrosa, *et al.*, 2005).

The biological oxidation of ammonium ion is called nitrification. The first step is done by several autotrophic bacteria from the genera Nitrosomonas, Nitrosolobus, and Nitrosospita. This involves the conversion of ammonium ion to nitrite. The nitrite ion is mobile and may be lost thru leaching or taken up by the plant. But, since the second step of nitrification occurs so rapidly, this usually does not occur. The Nitrobacter species rapidly converts the nitrite to nitrate. The bacteria involved require oxygen so in waterlogged soils the nitrification process will not occur. Also, lack of water will inhibit the nitrification process. They also prefer a slightly acid to neutral soil to provide rapid rates of nitrification (Pedrosa, *et al.*, 2005).

The nitrate form of nitrogen is the form most plants take up. But, this form is very mobile and may be losted through leaching. The rate of leaching and associated environmental problems is greater on sandy soils than clay soils. Irrigation and rainfall increase the amount of nitrogen lost by leaching. The amount of nitrate lost is depended on the quantity of nitrate available to be leached. Application of nitrogen fertiliser in excess can lead to significant nitrogen losses via leaching. This is especially true if nitrogen is added when plant growth is slow such as in the early spring or late fall (Pedrosa, *et al.*, 2005).

Additionally, under waterlogged conditions and even under normal soil moisture conditions where pockets of water occur in the soil, the nitrate may be converted by anaerobic bacteria such as Pseudomonas to nitrogen gas and lost to the atmosphere. The amount of loss is higher when soil moisture content is high, organic matter levels are high, and with higher pHs and temperatures. Additionally, nitrates must be available for the denitrification process to occur (Pedrosa, *et al.*, 2005).

2.4 Soil Particle-size Analysis

The arrangement of soil particle into aggregates and the subsequent arrangement of these aggregates in the soil profile are called soil structural type. The shapes of these aggregates are platy, prismlike, blocky, and granular or spheroidal. The textural class of a soil is determined in the laboratory by separating the soil particles in water, removing the sand with sieve, and measuring the silt and clay by their rate of fall in water using **mechanical analysis** or **particle-size** determination.

2.5 Soil pH

Soil pH is a measure of how acidic or basic things are and is measured using a pH scale between 0 to 14, with acidic things having a pH between 0-7 and basic things having a pH from 7 to 14. The pH of the soil solution is very important because soil solution carries in it nutrients such as Nitrogen (N), Potassium (K), and Phosphorus (P) that plants need in specific amounts to grow, thrive, and fight off diseases.

If the pH of the soil solution is increased above 5.5; Nitrogen (in the form of nitrate) is made available to plants. Phosphorus, on the other hand, is available to plants when soil pH is between 6.0 and 7.0. Certain bacteria help plants obtain N by converting atmospheric Nitrogen into a form of N that plants can use.

If the soil solution is too acidic plants cannot utilize N, P, K and other nutrients they need. In acidic soils, plants are more likely to take up toxic metals and some plants eventually die of toxicity or poisoning.

2.6 *Licuala spinosa* Thunberg – A Profile

2.6.1 Distribution

Licuala spinosa Thunberg is from Arecaceae family and commonly found in tropical country. The habitat for this species is moist, wet coastal areas and river banks. The common name for it is Mangrove Fan Palm.

2.6.2 Description

L. spinosa is very vigorous and attractive palm, forming large clumps to about 3-4 meters high. It has large round divided leaves up to a meter across, with the leaf stalks being quite heavily spine.

Figure 1: *Licuala spinosa* seedling.

Figure 2: *L. spinosa* tree in Kuching, Borneo.

CHAPTER 3

MATERIALS AND METHOD

3.1 Materials

3.1.1 Collection of Seedlings and Site Preparation

Licuala spinosa Thunberg seedlings were obtained from Sarawak Forest Corporation Tree Seed Bank (SFCTSB) in Semengoh, Padawan. Forty uniform seedlings in terms of their height were selected for the study. The seedlings were transplanted in the pot medium filled with 7:3:2 mixture of soil (7 parts agriculture soil: 3 parts sand: 1 part organic matter). The soil was sieved to remove stones and other unwanted materials. The experiment was done in Universiti Malaysia Sarawak (UNIMAS) green house. The seedlings were grown under netting material with light intensity of approximately 50 %.

3.2 Methods

3.2.1 Experimental Design and Treatments

The experiment is a 4 x 1 factorial design arranged in randomized complete block. There were 40 polybags involving 5 treatments (8 seedlings per treatment). Table 1.0 gives the treatment applied.

Table 1: Levels of Fertiliser Applied for each treatment.

Treatment	Amount Added (g/pot) of NPK (20-10-5)
F0	No fertiliser and well-watered
F1	25 g of fertiliser and well-watered
F2	50 g of fertiliser and well-watered
F3	75 g of fertiliser and well-watered
F4	100 g of fertiliser and well-watered

3.2.2 Fast Release Fertiliser

Fast release fertiliser was applied only once for every 5 months at the beginning of the treatment and placed 10 cm below the surface (NPK 15-15-15).

3.2.3 Data Analysis

The experimental design used was 'Completely Randomized Design'. All data obtained was analyzed using Analysis of Variance.